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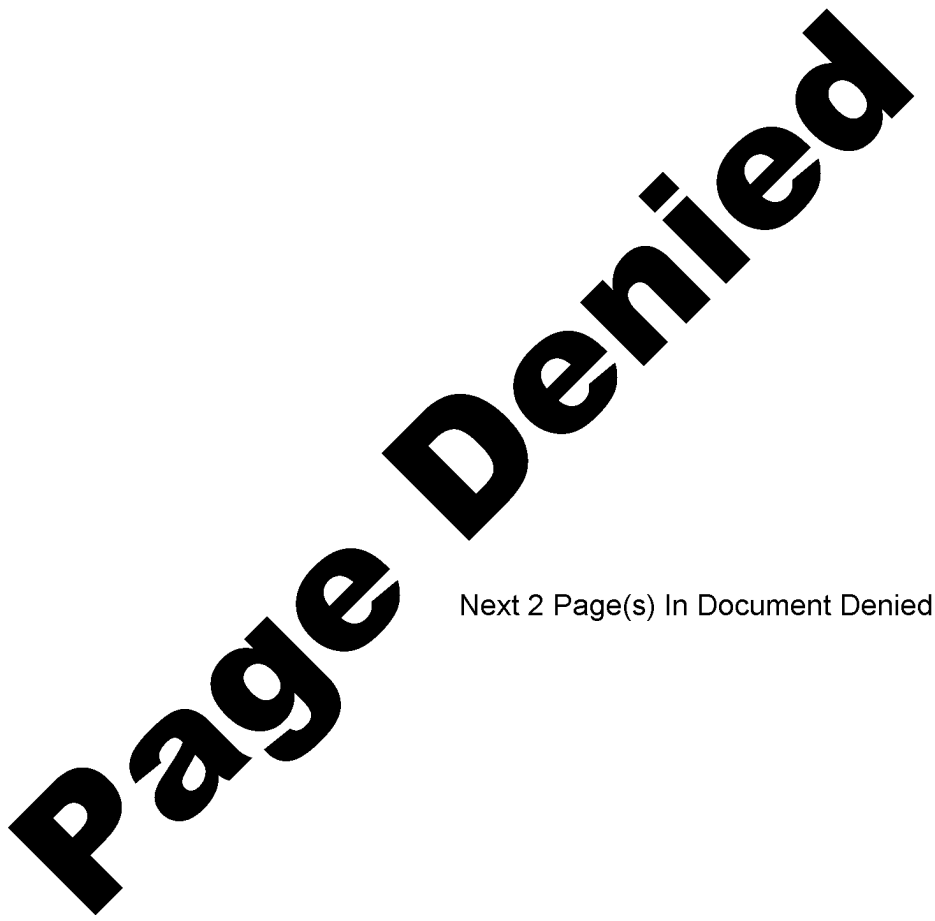

Next 2 Page(s) In Document Denied

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SUBJECT

MILITARY THOUGHT (USSR): Increasing the Speed of Transport of Operational-Tactical Missiles

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Increasing the Speed of Transport of Operational-Tactical Missiles

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One of the ways of increasing the mobility of missile and missile technical units and large units, which still is inadequate at present, is, as we know, to increase the speed of transporting the missiles. Research and the experience of operating missile systems show that real possibilities exist for considerably increasing the speed of transporting operational-tactical missiles without design modification of items of ground equipment. This article is devoted to that subject.

Among the basic factors limiting the speed of transport of missiles on launchers and other items of ground equipment, the magnitude of permissible loads to be undergone by missiles while being transported is particularly important. The loading on a missile depends on the intensity and nature of vibrations of the sprung masses which occur while the equipment is moving over road roughness.

Researching the dynamic loads on missiles being transported by road involves great difficulties. This is explained first by the fact that the missile vibrations are described by a cumbersome system of equations, the analytic solution of which is quite difficult. Secondly, the existing theory of spring-mounting transport means usually considers as perturbations only that isolated or periodically recurring road roughness having regularity in its variation. Actually, when missile transport means move by road the external actions upon the wheels from the roughness are of an irregular, random nature. Therefore, the theory of random functions is of great practical interest to researching the vibrations of missiles and consequently their dynamic loading.

The statistical method of researching missile vibrations permits us to analyze their accelerations, determine, under various operating conditions, the probability of the emergence of dynamic loads which exceed the permissible values, and thus proceed to a valid assignment of maximum speeds for the transport of missiles on various types of roads.

Under combat conditions missiles are transported on roads with various types of surfacing and at different stages of readiness. Furthermore, even on roads of good quality they may encounter obstacles (bomb and shell craters, pits, deep indentations and others), which will differ greatly in magnitude from the general nature of the roughness of existing types of roads. Therefore the dynamic loads on missiles being transported must be determined by the statistical method, and, in the case of negotiating single obstacles, by the method of the determinative theory of the smoothness of motion.

In this connection it has become necessary to develop the methods and instrumentation which will permit obtaining these characteristics with high efficiency and sufficient accuracy.

The accepted method consists of recording by oscillogram the experienced second-order derivatives of the perturbation functions for various types of roads, using a specially developed device whose elements shift according to the road surface. The spectral densities of the perturbation functions for various types of roads, which vary with the speed of movement of the missile transport means, are determined by processing the oscillograms.

The spectral densities of the perturbation functions for various types of roads, obtained by this method, and the calculated frequency characteristics of the dynamic systems of equivalent items of equipment, can be used for computing and constructing graphs illustrating the magnitude of the deviations, and the root-mean-square accelerations of the missiles, and for establishing the dependence of these factors on the speed of movement of the transport means. The graphs in turn make it possible to determine, in terms of the permissible values of missile accelerations, the maximum permissible speeds at which to transport them on various segments of the route and the probability of the emergence of accelerations which exceed the permissible limits.

The results of calculating permissible speeds for transporting operational-tactical missiles on items of missile system ground equipment on various types of roads are shown in the table.

Type of transport means	Missile classification number	Stage of missile readiness	Permissible accelerations (g)	Permissible speeds, kph		
				Asphalt surface roads	Cobbled roads	Unpaved roads
Equipment item 9P117	8K14	No. 3	3	71	71	71
Trailer 2TZ (prime mover ZIL-157B)	8K14	No. 4	3	50-53	36-40	26-28
Trailer 2TZ (prime mover ZIL-157B)	8K14	No. 6	3	50-53	38-40	26-28
Trailer 8T137 (prime mover ZIL-157B)	8K11	No. 4	2	40-44	30-34	25-27

The data obtained permit us to conclude that the maximum permissible speeds for transporting missiles in all the conditions examined may be increased, relative to the requirements of the technical conditions for transporting, as follows: for missiles transported on equipment item 9P117 on paved roads, an average of 1.2 times, and on unpaved roads, 1.4 times; for missiles transported on 2TZ and 8T137 trailers, 1.3 - 1.4 times, depending on the type of road.

The above estimated values of permissible speeds for transporting missiles are corroborated by the scientific research work carried out by the Military Artillery Academy and Military Unit 42261, and by special transportation tests, as well as the experience of exercises conducted by order of the Commander of Rocket Troops and Artillery, when missiles were carried at speeds approximating those shown in the table. In these tests the dynamic loads experienced by the missiles did not exceed the permissible limits. As shown by subsequent operational launches, all missiles subjected to transport remained in full operating condition and provided the specified close grouping of fire.

Thus, the statistical method of determining maximum permissible speeds for transporting missiles permits us to allow for the actual road conditions on specific segments of a route and make a valid approach to the problem of determining average speeds of column movement when planning a march to be made by missile and missile technical units. This undoubtedly gives us the capability of significantly increasing the speeds of transporting missiles, especially when carrying out marches over long distances.

It should be noted that the permissible speeds for transporting missiles may be estimated in advance using the statistical method, by allowing for the probable road microprofile characteristics along the proposed march route. In a number of cases the troops can make these estimates themselves on the basis of available statistical data on the perturbation functions for the roads, by using keyboard calculators.

To obtain accurate statistical microprofile characteristics of roads along which troops plan to march, it would be desirable to develop a small-size device which would permit determining the spectral densities of the perturbation functions for the roads immediately before the march, during reconnaissance of the movement routes of the columns of missile and missile technical units. It is entirely possible to develop such a device on the basis of existing random-functions analyzers. The availability to troops of this device will permit them to make a valid determination of the

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maximum permissible speeds for transporting missiles, with allowance for actual road conditions, thus ensuring their preservation and combat effectiveness.

Solving this problem will help to increase the mobility of missile and missile technical units and subunits.

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